

The Environment and Your Health

(A Case Study)



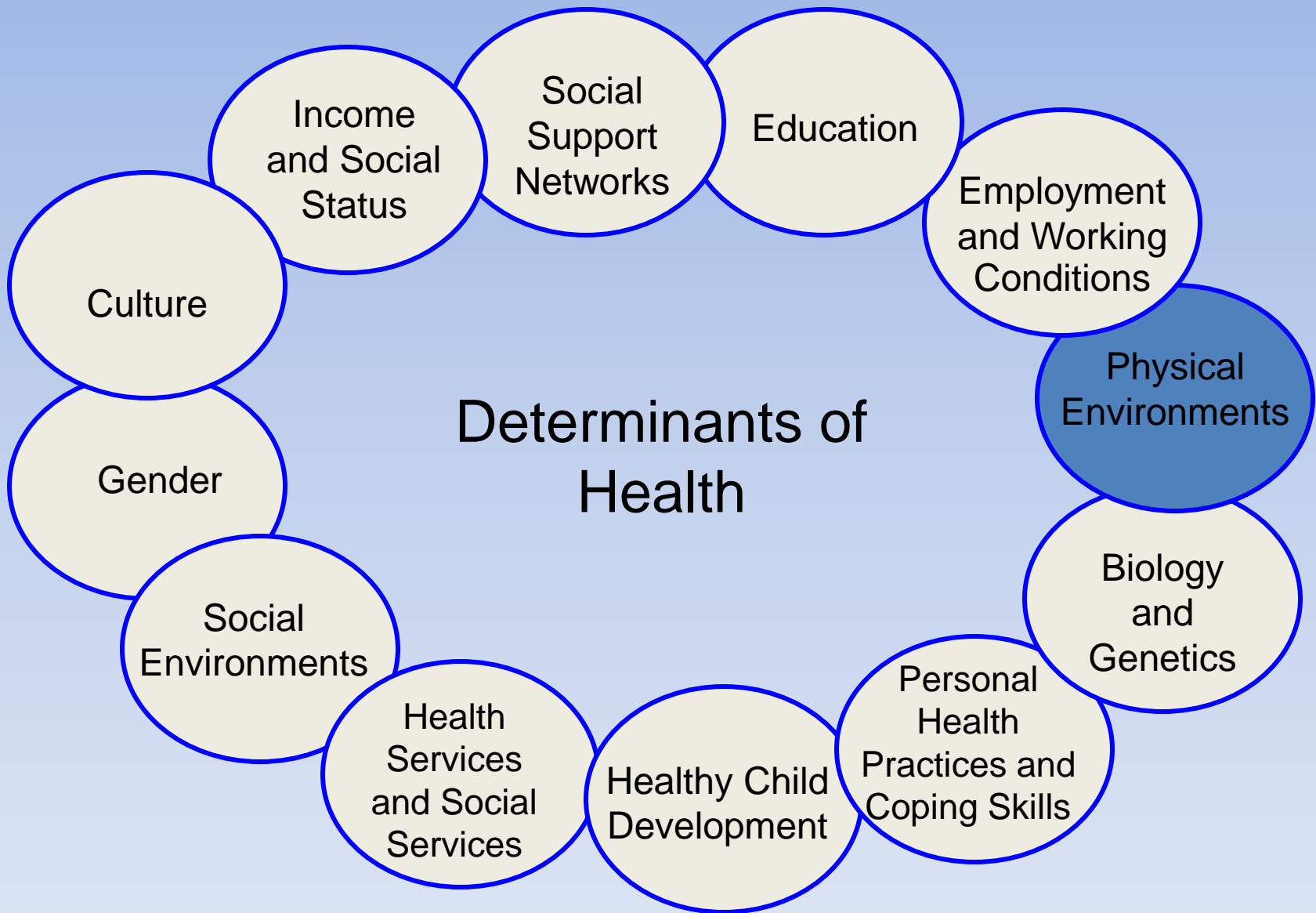
Wyoming
Department
of Health

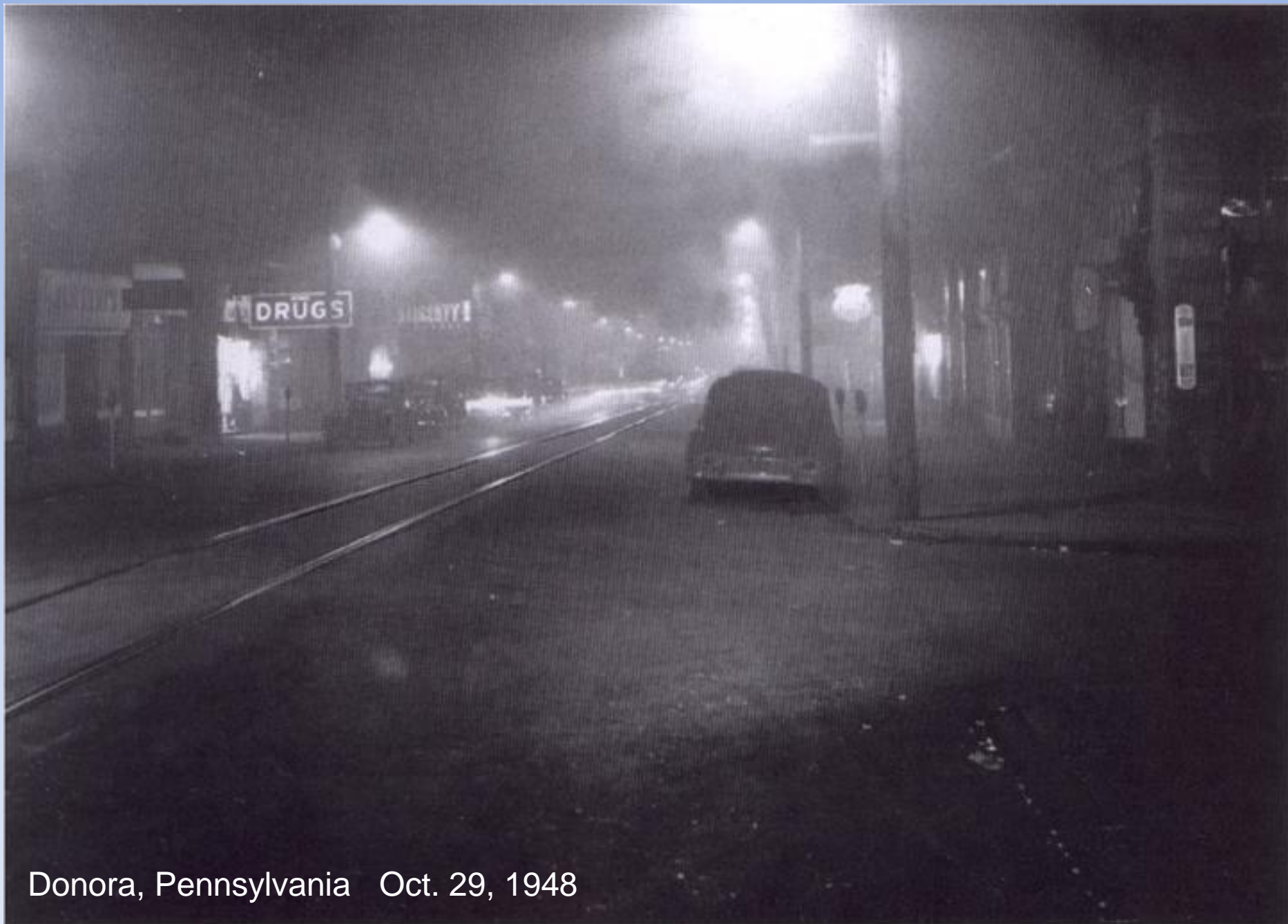
Commit to your health.

Wyoming Chronic Disease Conference
Cheyenne, WY

Outline

- Particulate Matter & Ozone
- Chronic Disease/Environment
- Sublette County Air Quality
- Addressing the Problem

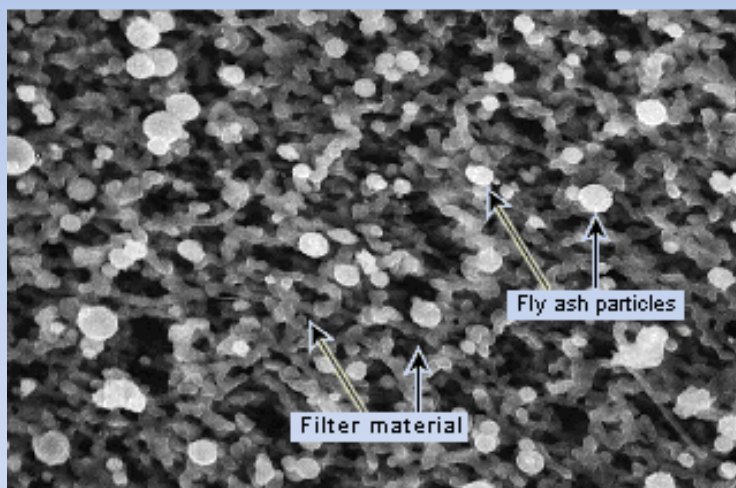




Donora, Pennsylvania Oct. 29, 1948

What is Particulate Matter?

Figure 1. Photomicrograph of Fly Ash Particles on an MCE Filter



Source: Courtesy of Air Control Techniques, P.C.

Image from <http://www.epa.gov/eogapti1/module3/distribu/distribu.htm>

Particulate matter (PM)

describes a wide variety of airborne material. PM pollution consists of materials (including dust, smoke, and soot), that are directly emitted into the air or result from the transformation of gaseous pollutants. Particles come from natural sources (e.g., volcanic eruptions) and human activities such as burning fossil fuels, incinerating wastes, and smelting metals.

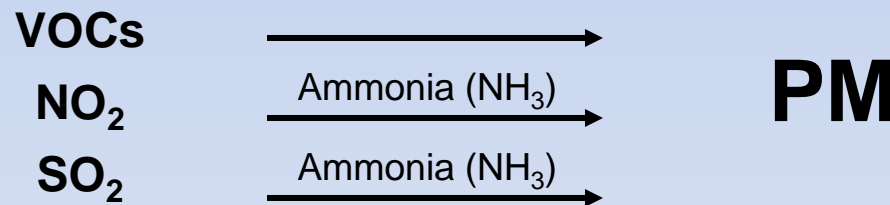
How is PM Regulated?

PM is one of the six **EPA “criteria pollutants”** that have been determined to be harmful to public health and the environment. (The other five are ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead.)

EPA is required under the Clean Air Act to set **national ambient air quality standards (NAAQS)** to protect public health from exposure to these pollutants. Areas that exceed the NAAQS are designated as **nonattainment**, and must institute air pollution control programs to reduce air pollution to levels that meet the NAAQS.

Where Does PM Originate?

Sources may emit PM directly into the environment or emit **precursors** such as **sulfur dioxide (SO_2)**, **nitrogen dioxide (NO_2)**, and **volatile organic compounds (VOCs)**, which are transformed through atmospheric chemistry to form PM.



Sources of PM and PM Precursors



Mobile Sources

(vehicles)

VOCs, NO₂, PM



Stationary Sources

(power plants, factories)

NO₂, SO₂, PM



Area Sources

(drycleaners, gas stations)

VOCs



Natural Sources

(forest fires, volcanoes)

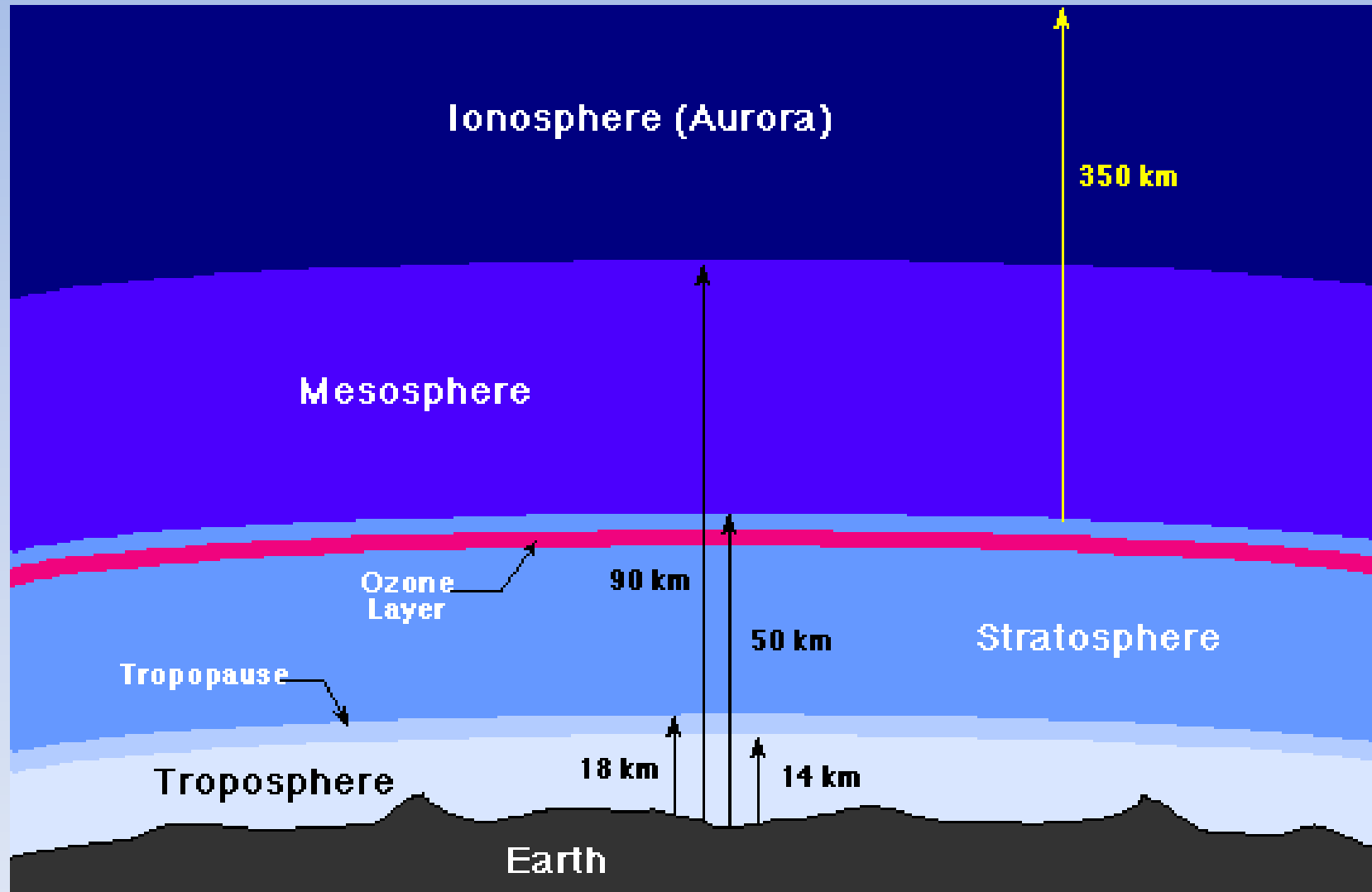
PM

Determinants of PM Concentration

- Weather patterns
- Wind
- Stability (vertical movement of air)
- Turbulence
- Precipitation
- Topography
- Smokestack height and temperature of gases

Nearby natural and built structures may lead to downward moving currents causing **aerodynamic or building downwash** of smokestack emissions.

Our Atmosphere

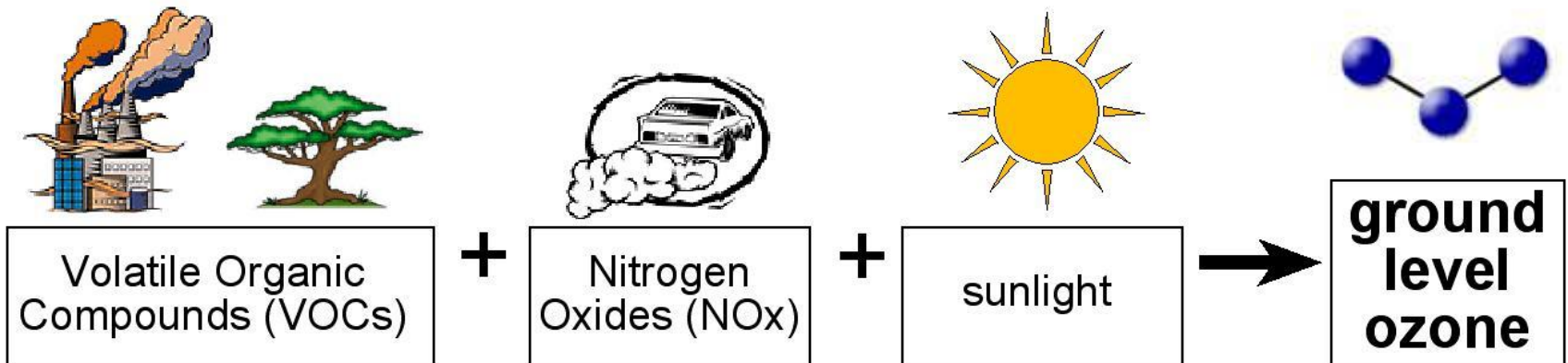


What is Ozone?

- An odorless, colorless gas composed of three oxygen atoms.
- Ozone in the upper atmosphere protects us from the sun's harmful ultraviolet rays.
- At ground-level in the air we breathe, ozone (smog) poses serious risks to human health.

Ozone: Troposphere Development

Ground level ozone is formed via a chemical reaction



- VOCs come primarily from vegetation and industrial sources.
- NOx comes from automobiles, trucks, buses, and power plants.
- Ozone pollution is a concern primarily during the summer months when the weather conditions to form it (lots of sun and hot temperatures) normally occur. Not true in Wyoming!

Level of Ozone and the Impact on Human Health

Air Quality	Ozone (ppb)*	Active Children and Adults; People with Respiratory Disease	Everyone Else
Good	0-64	None	None
Moderate	65-84	Unusually sensitive individuals may experience respiratory effects.	None
Unhealthy for Sensitive Groups	85-104	Increasing likelihood of respiratory effects (coughing or pain when taking a deep breath) and reduced lung function	None
Unhealthy	105-124	Greater likelihood of respiratory effects (aggravated cough or pain when taking a deep breath) and reduced lung function.	Possible respiratory effects
Very Unhealthy	>125	Increasingly severe symptoms and impaired breathing likely.	Increasing likelihood of respiratory effects

*Ozone thresholds are for 8 hour averages; ppb = parts-per-billion

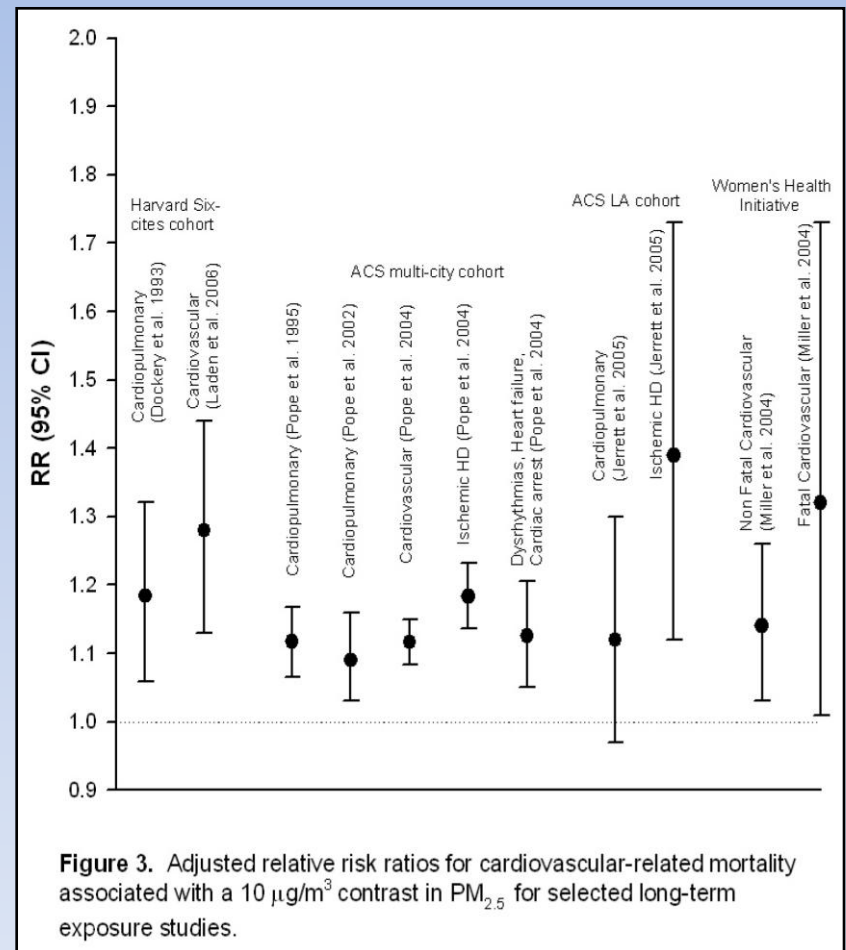
What Adverse Health Effects Have Been Linked to PM & Ozone?

- Premature death
- Lung cancer
- Exacerbation of COPD
- Development of chronic lung disease
- Heart attacks
- Hospital admissions and ER visits for heart and lung disease
- Respiratory symptoms and medication use in people with chronic lung disease and asthma
- Decreased lung function
- Nose & throat irritation
- Pre-term birth
- Low birth weight

Increasing Evidence of Cardiovascular Effects

Until the mid 1990s, most research focused on the association of PM exposure with respiratory disease. Since then, there has been growing evidence of **cardiovascular health effects** from PM.

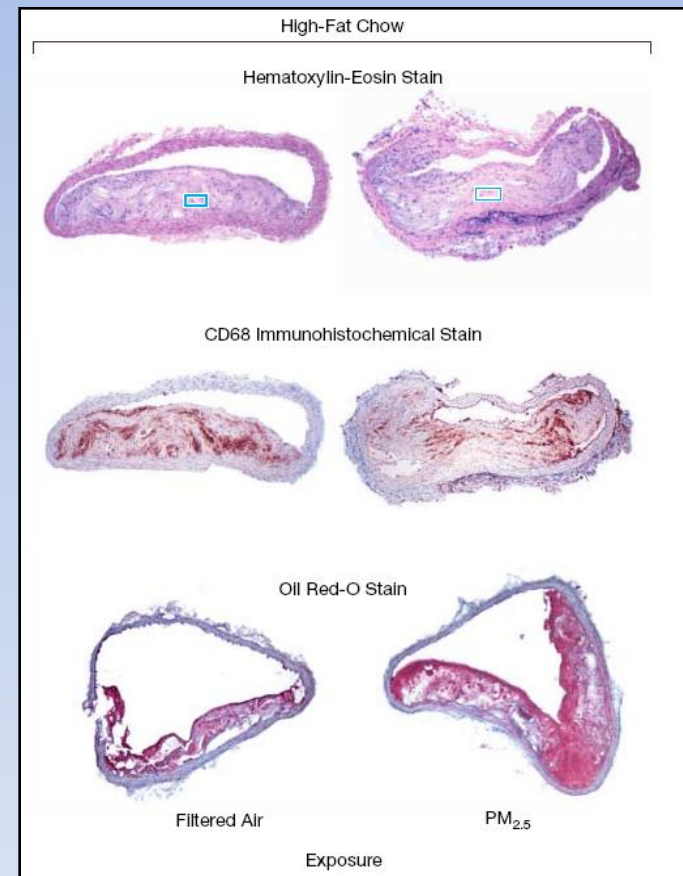
Source: Pope and Dockery, *JAWMA*, 2006



Integrating Toxicology, Epidemiology and Clinical Studies

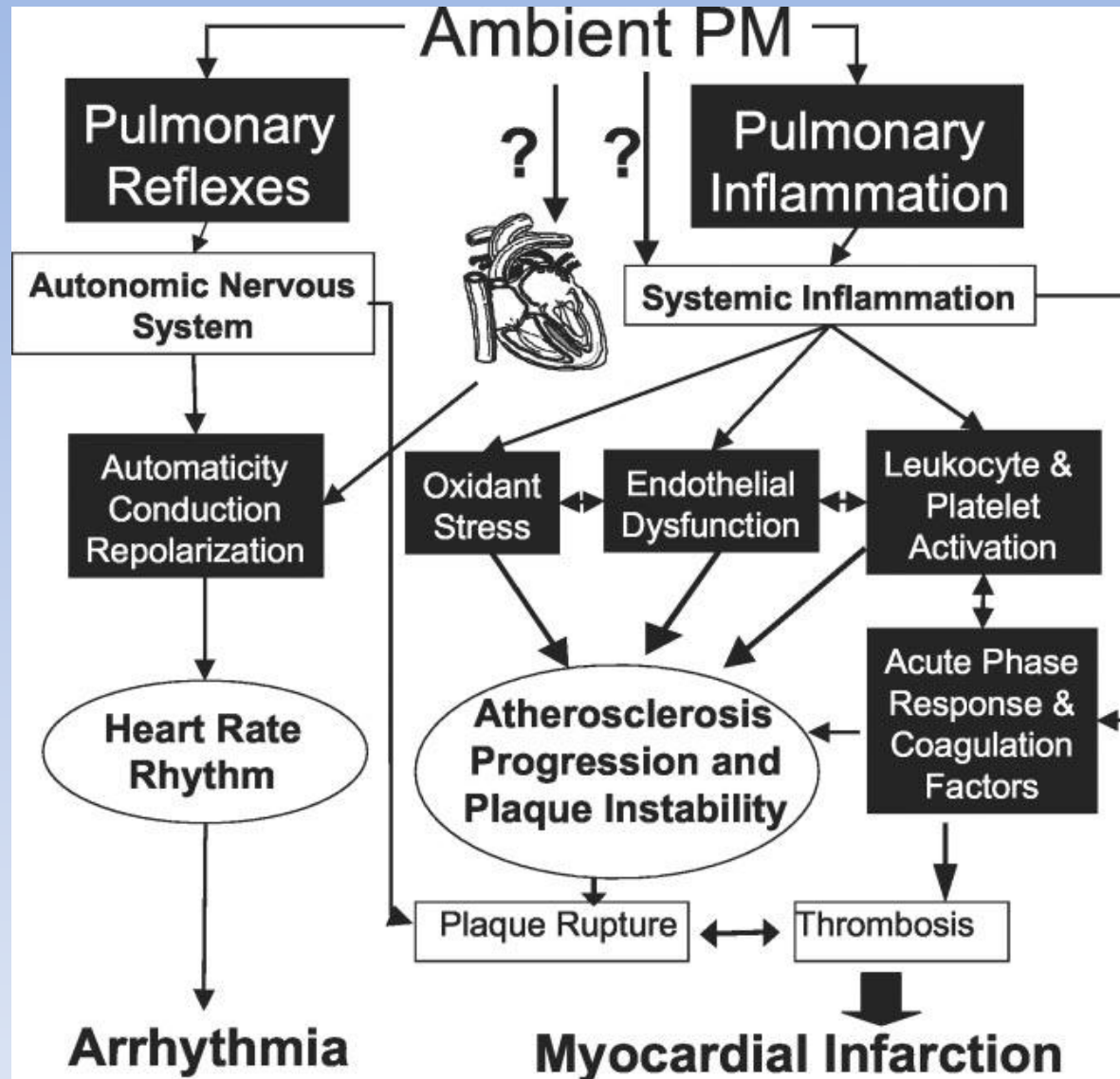
Toxicological, clinical and **epidemiological** studies have increased understanding of the **mechanism of action** by which PM leads to mortality and lung and heart disease.

For example, at right are stained photomicrographs of abdominal arteries from mice exposed to filtered air and air polluted with fine particulate matter, with the increased arterial blockage in the PM-exposed mice providing scientific support for the link between PM and atherosclerosis found in a study of human subjects (Kunzli et al., 2005).



Sun et al. *JAMA*, 2005

Possible biological mechanisms linking PM with cardiovascular disease.

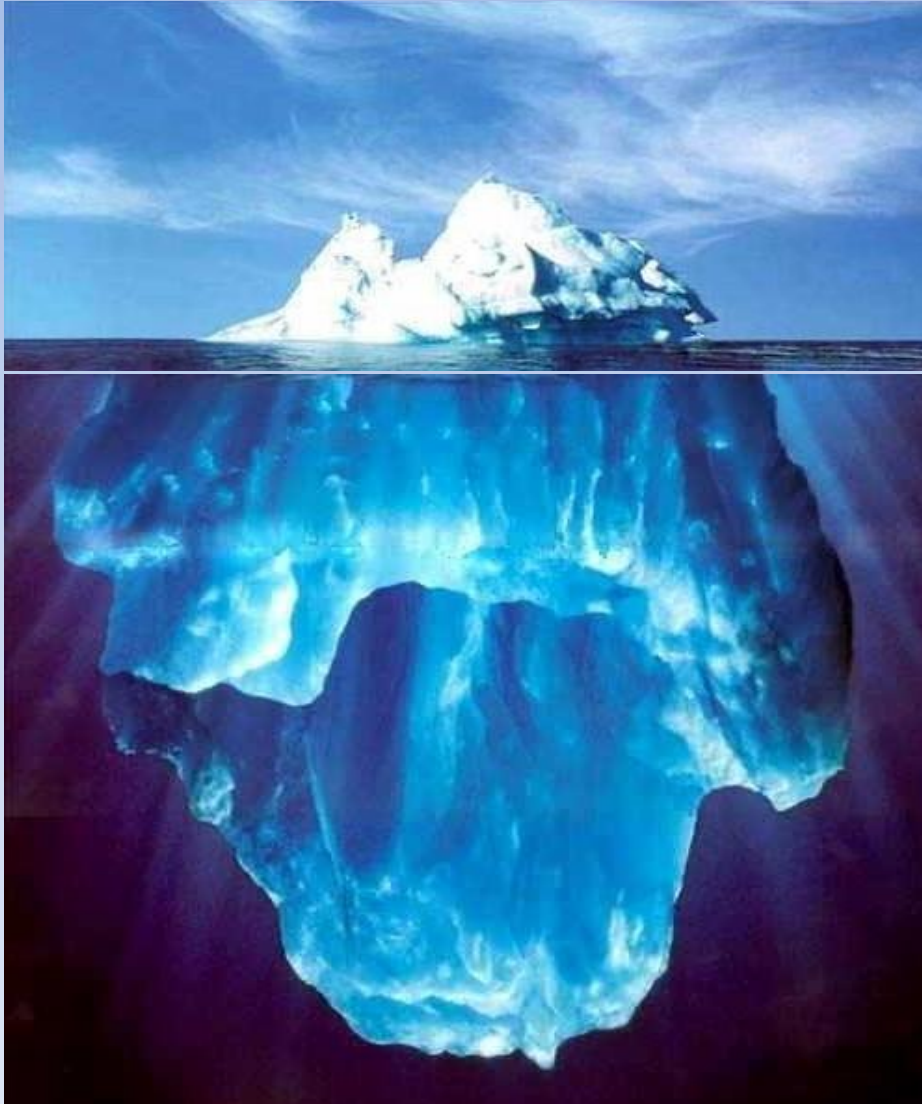


How Does PM/Ozone Cause Health Effects?

Several theories have been advanced as to the mechanism of action. It is likely that more than one mechanism is involved in causing PM-related health effects. Theories include the following:

1. PM leads to lung **irritation** which leads to increase permeability in lung tissue;
2. PM increases **susceptibility to viral and bacterial pathogens** leading to pneumonia in vulnerable persons who are unable to clear these infections;
3. PM **aggravates the severity of chronic lung diseases** causing rapid loss of airway function;
4. PM causes **inflammation** of lung tissue, resulting in the release of chemicals that impact heart function;
5. PM causes **changes in blood chemistry** that results in clots that can cause heart attacks.

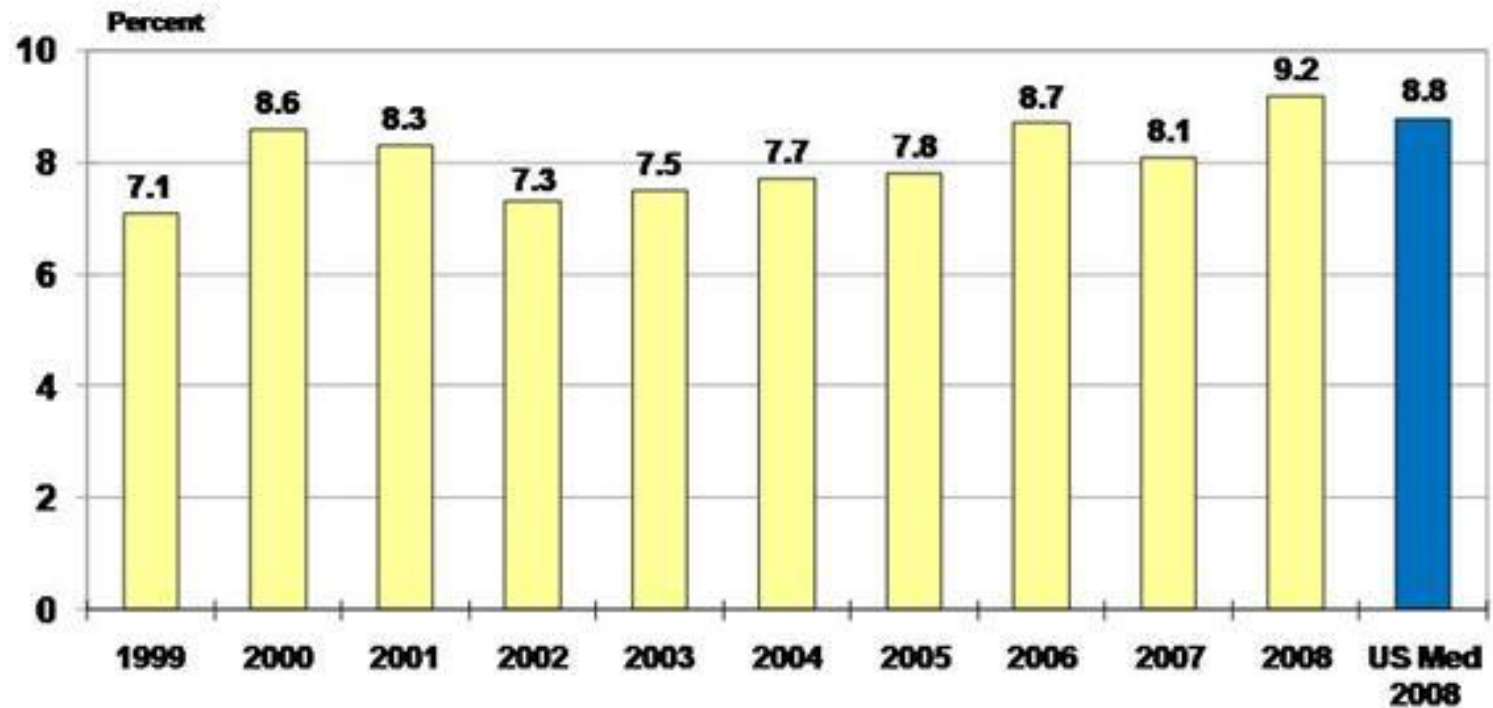
Tip of the Iceberg



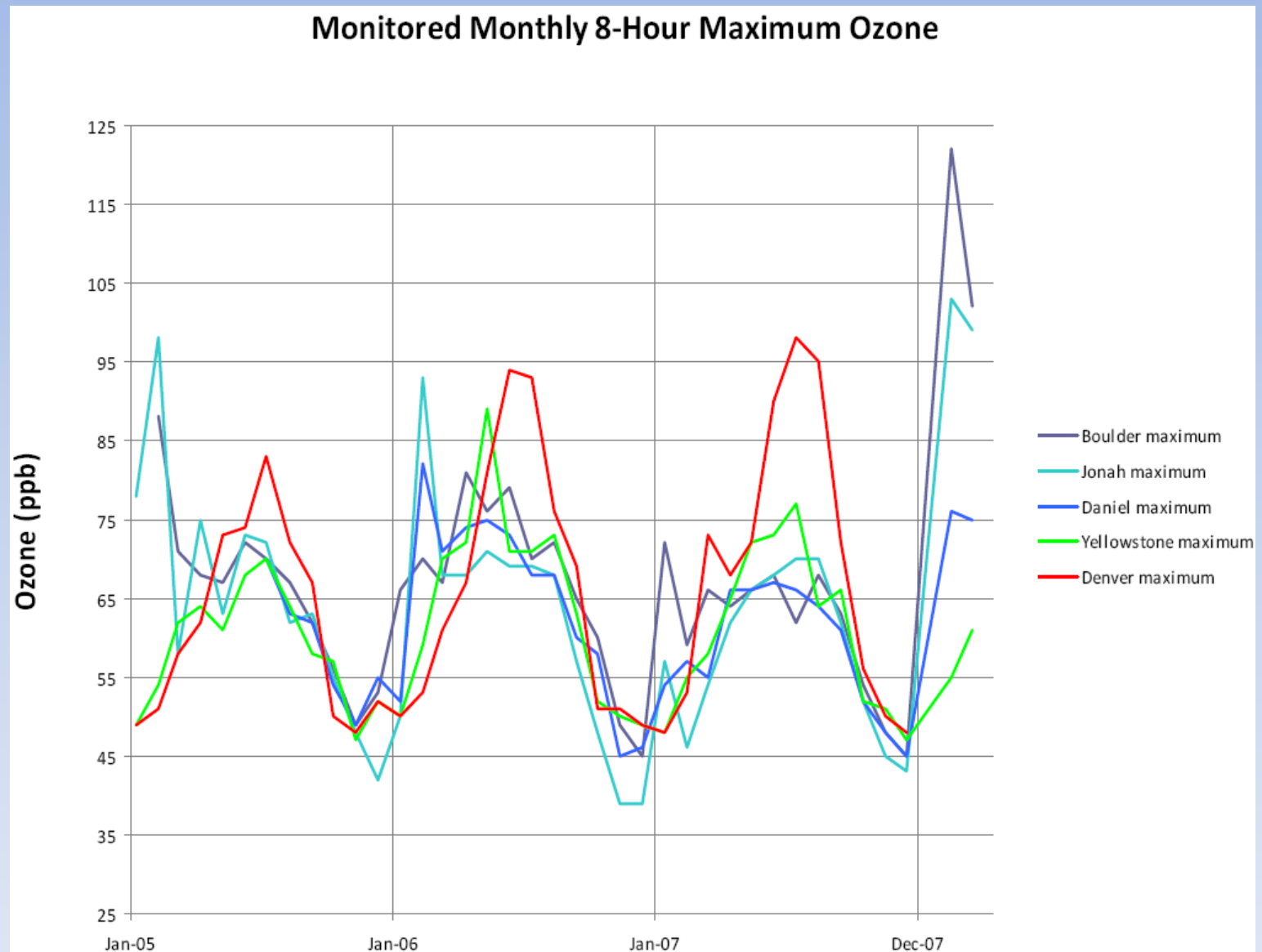
death
hospital
admissions

emergency room visits
physician office visits
reduced physical activity
medication use
respiratory symptoms
impaired lung function
subclinical (subtle) effects

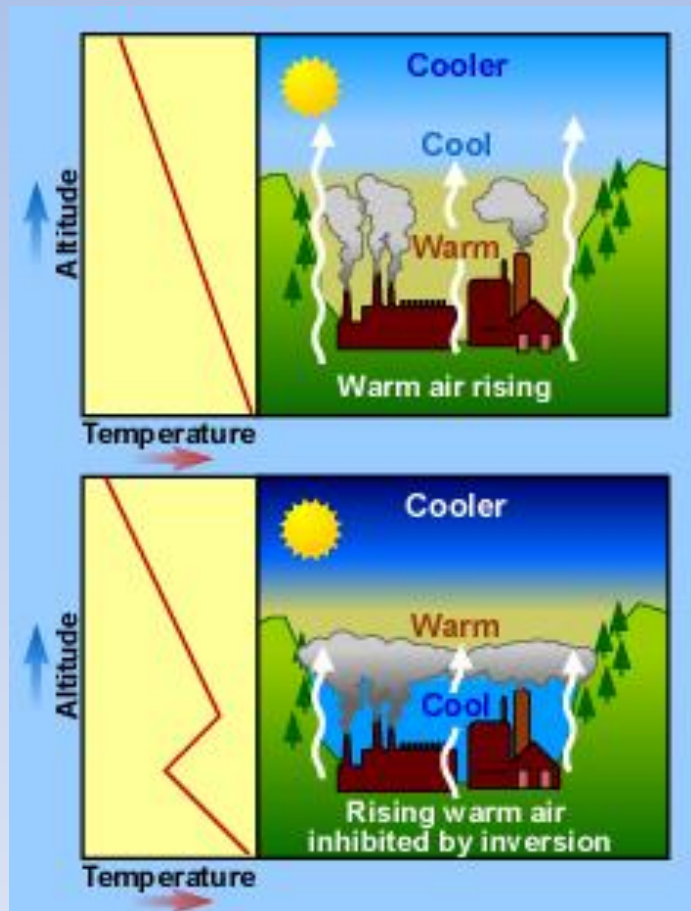
Current Asthma by Year, WY BRFSS



A Local Problem

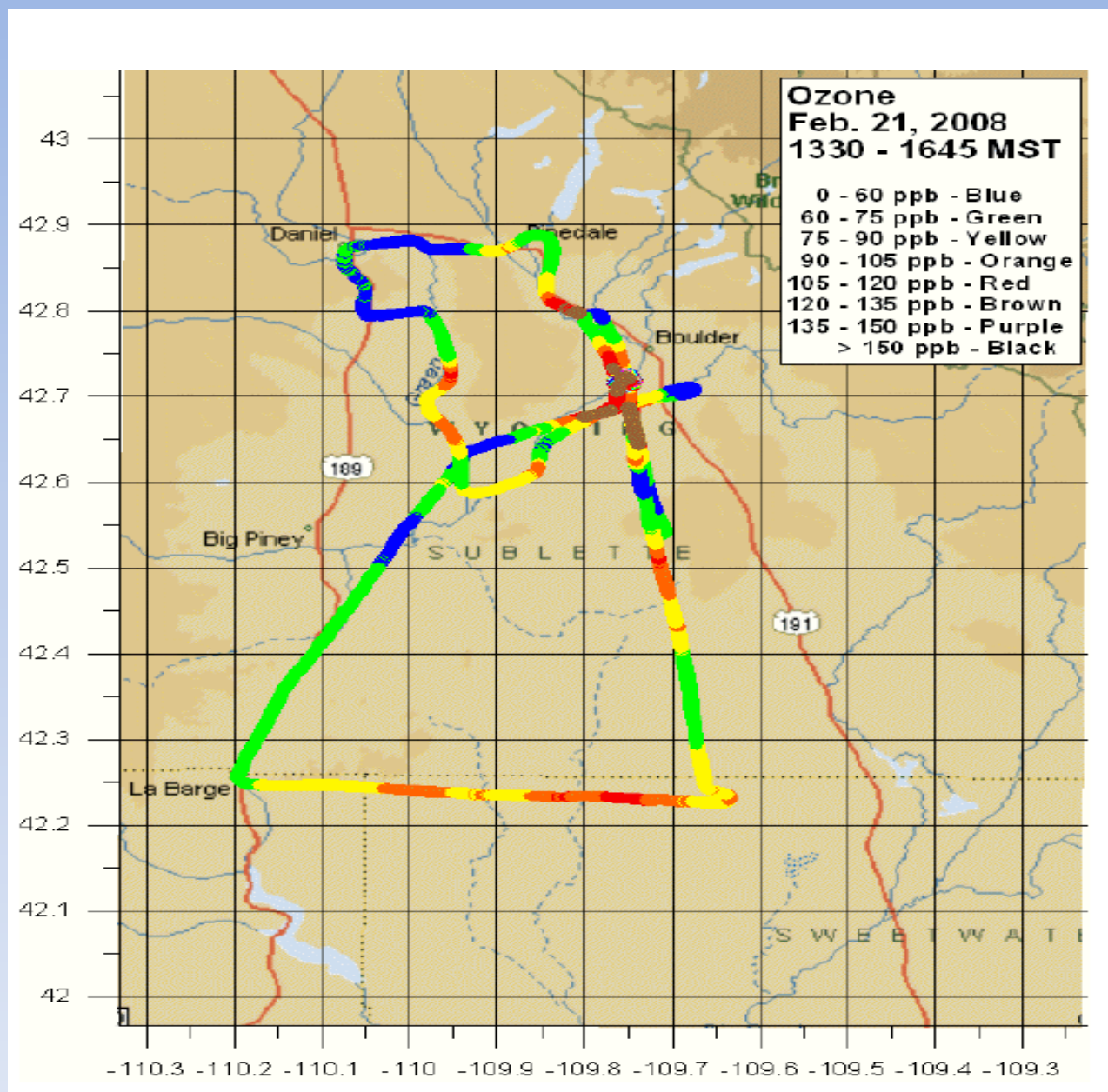


The Role of Inversions



An inversion is an extremely stable layer of the atmosphere that forms over areas.

Temperature inversions trap pollutants close to the ground. These inversions involve layers of hot air sitting above cooler air near ground level. When particles accumulate in the air layer, they are unable to rise into the atmosphere where winds will disperse them.



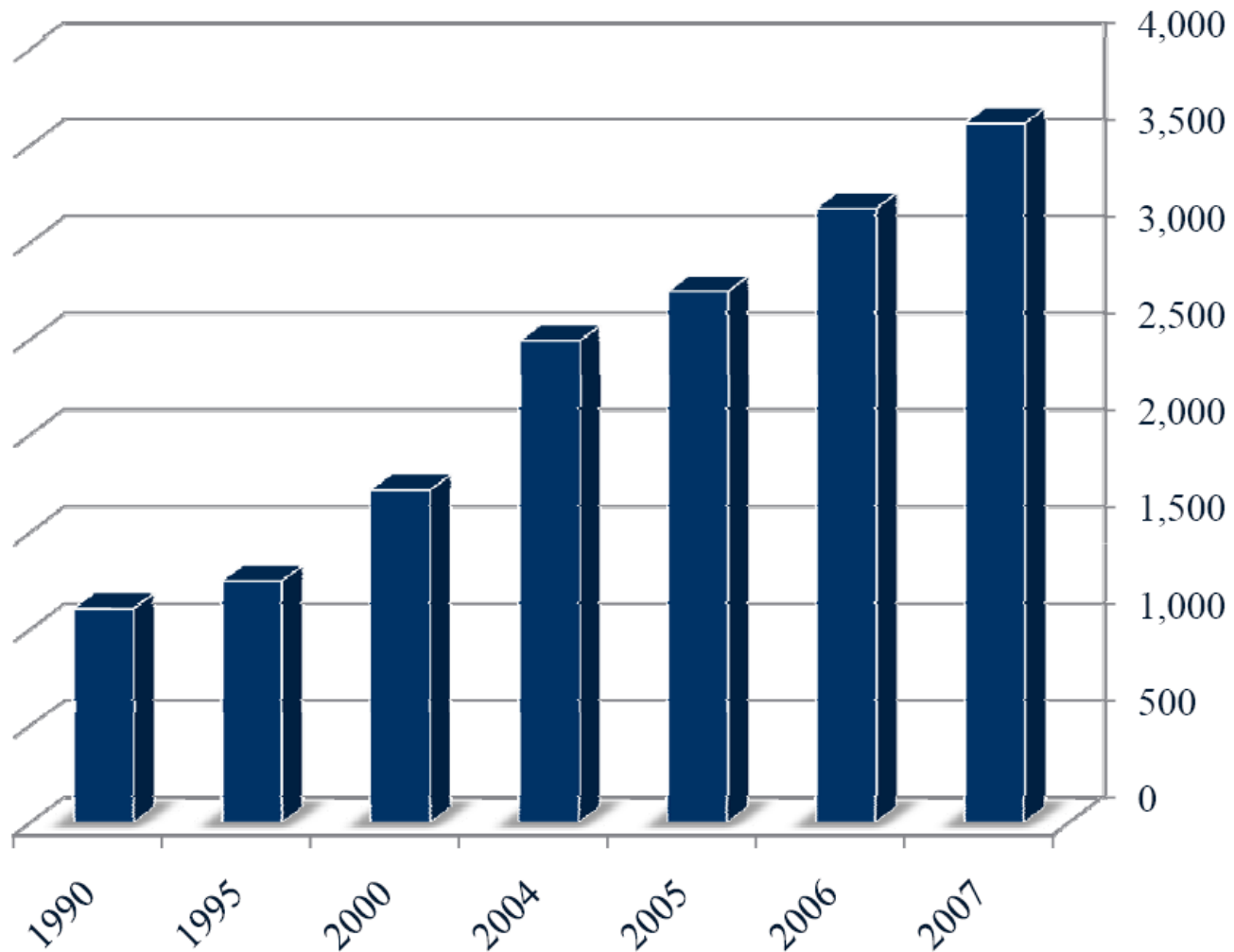
AQD Monitoring Site 4th high 8-hour ozone values (ppm)

These sites have 3 complete years of data for 2005-2007

Site	2005	2006	2007	2005-2007 Average	2008 YTD value
Thunder Basin	0.063	0.072	0.072	0.069	0.074
Campbell County	0.063	0.065	0.072	0.067	0.050
Yellowstone	0.060	0.069	0.065	0.065	0.061
Boulder	0.079	0.072	0.067	0.072	0.101
Jonah	0.075	0.069	0.068	0.070	0.082

Natural Gas Development

Total Sublette County Wells



What the State is Doing

Timeline

Goal: Prevent ozone from exceeding health-based standards

Offset new emissions

Reduce VOC and NO_x emissions from existing sources (voluntary and mandatory)

Develop interim ambient model to determine emission inventory needed to reach attainment

Develop 3-D ambient model to determine emission inventory needed to reach attainment

DEQ
Actions

Adjust offset and existing emission reduction requirements

2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Submit area designation

State submits SIP

State submits a maintenance SIP

Federal
Nonattainment
Actions

EPA issues formal designation

Area returns to attainment status

State prepares SIP

Air Toxics Monitoring Locations

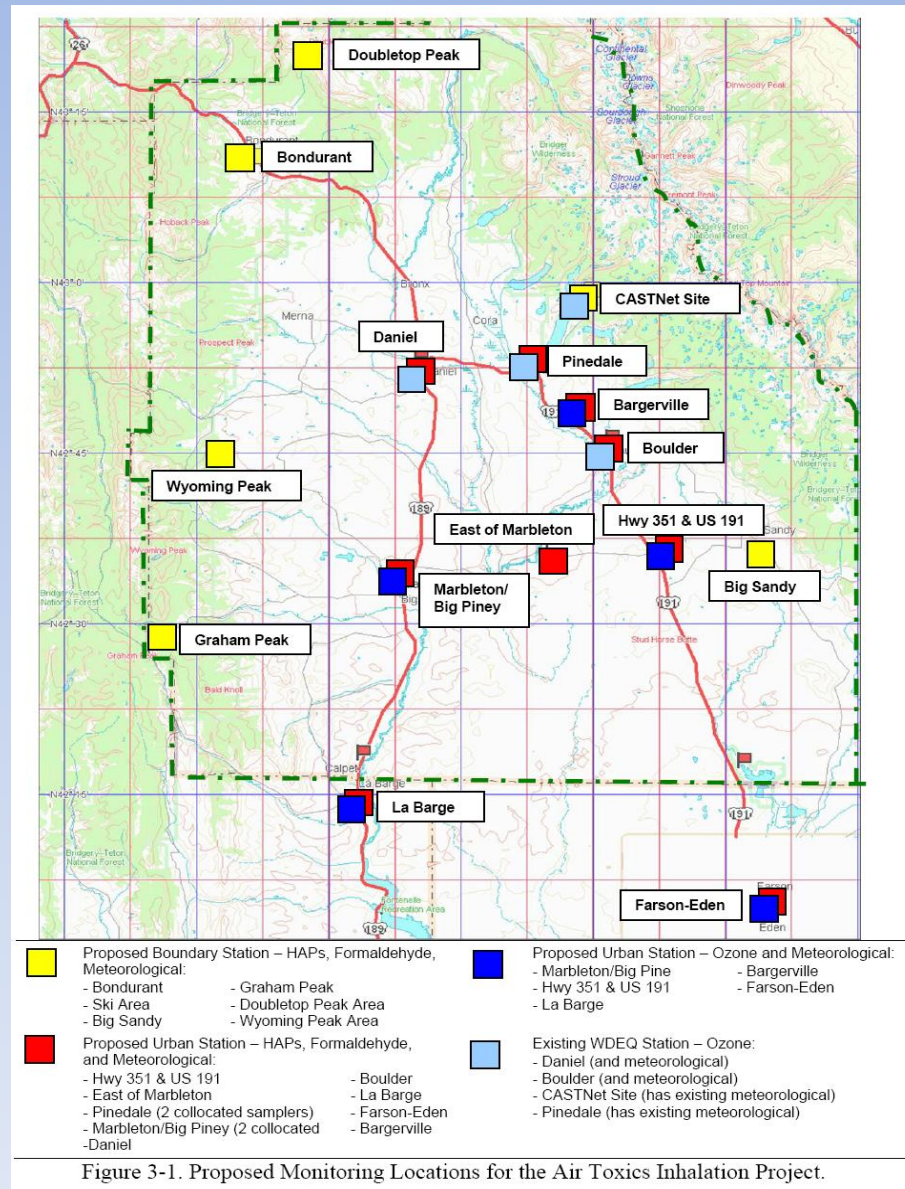


Figure 3-1. Proposed Monitoring Locations for the Air Toxics Inhalation Project.

AMBIENT AIR QUALITY MONITOR IN PINEDALE

Why this location is a **GREAT** location for an ambient air quality monitor:

- 1) Meets EPA sighting criteria for air quality monitors
- 2) Located close to residential area
- 3) Located close to power
- 4) Not immediately next to minor sources (e.g. gravel crushing, maintenance shop, hotels with trucks idling) that could cause localized influences on the station
- 5) City-supported and cooperative partners



Actual City Lot Where Monitor Will Be Located



Example of What the Monitor Will Look Like (*Actually Daniel South*)

SUBLETTE COUNTY HUMAN HEALTH RISK ASSESSMENT AIR TOXICS INHALATION

- Conduct a study of the risks to human health for citizens of Sublette County who are exposed to air toxics and ozone as they live and work in the County.
- An air toxics risk assessment includes:
 - selection of chemicals of potential concern,
 - collection of air samples to be analyzed for the chemicals of potential concern
 - collection of a subset of samples to be analyzed for a broader range of constituents
 - collection of samples for ozone for evaluation
 - an exposure assessment
 - determination of the exposure patterns for residents
 - determination of the exposure patterns for sensitive subpopulations
 - assessment of the expected human health risk resulting from exposure of residents to air toxics and ozone